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ABSTRACT

In 1980, the Michigan Educational Assessment Program (MEAP) revised the instruments used to assess basic skills attainment in mathematics and reading of all students in grades 4, 7, and 10. The research summarized in this paper examined the factor structures of the 1979 and 1980 versions of the Grade 10 MEAP mathematics test. These two versions were found to be different in factor structure. In addition, a subset of the objectives which was common to the two versions was found to behave differently depending on which version of the test was used to assess it. Decisions made using each of the versions were also investigated. These decisions, using MEAP criteria, were found to be dependent upon which version of the test was used to make them. (Author)

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WHAT HAPPENS WHEN WE CHANGE THE TEST?--A FACTOR ANALYSIS OF TWO FORMS OF THE MICHIGAN EDUCATIONAL ASSESSMENT PROGRAM GRADE TEN MATHEMATICS TEST

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Abstract

In 1980, the Michigan Educational Assessment Program (MEAP) revised the instruments used to assess basic skills attainment in mathematics and reading of all students in grades four, seven, and ten. The research summarized in this paper examined the factor structures of the 1979 and 1980 versions of the Grade 10 MEAP mathematics test. These two versions were found to be different in factor structure. In addition, a subset of the objectives which was common to the two versions was found to behave differently depending on which version of the test was used to assess it. Decisions made using each of the versions were also investigated. These decisions, using MEAP criteria, were found to be dependent upon which version of the test was used to make them.

What Happens When We Change the Test?--A Factor Analysis of Two Forms of the Michigan Educational Assessment Program Grade Ten Mathematics Test

Background and Overview

The assessment of basic reading and mathematics skills has been a high priority concern in the state of Michigan since the late 1960's. In 1969, the State Department of Education, under the leadership of John Porter, instituted a testing program designed to assess the level of basic skills attainment for Michigan students in these two curricular areas. This program is called the Michigan Educational Assessment Program (MEAP).

The first versions of the MEAP tests were norm-referenced and were designed to assess student performance in word relationships, reading, mechanics of written English, and mathematics on a state-wide basis. Norm-referenced comparisons among local school districts were made based upon the results of these tests. These comparisons resulted in a controversy between the State Department of Education and the Michigan Association of School Administrators (McCormick, 1978) which centered around the interpretation of MEAP results as measures of school quality. The Professors of Educational Administration's Task Force on Accountability also criticized the norm-referenced MEAP based, in part, on the involvement of the Educational Testing Service in its construction (McCormick, 1978).

These criticisms helped to precipitate a change in the MEAP. In 1973, the assessment instruments were changed from norm-referenced to objective-referenced tests. The first objective-referenced tests assessed the basic skills in reading and mathematics of all Michigan pupils in grades four and seven each year from 1973 through 1979. In 1979, grade ten students were also assessed in these two areas.

In mathematics, 455 objectives had been written which Michigan students were expected to master by the end of Grade 9. Of these 455 objectives, 33 were assessed at Grade 4, 45 were assessed at Grade 7, and 40 were assessed at Grade 10 on the first objective-referenced MEAP tests. The same objectives were assessed each year. Test items used on the MEAP mathematics tests were reviewed by the Michigan Council of Teachers of Mathematics and many Michigan mathematics teachers in order to establish their validity.

The MEAP tests were revised extensively in 1980. This revision was the result of a process begun five years earlier which included revising the minimal performance objectives. In mathematics, the number of objectives was increased to 624. The MEAP instruments were restructured in the interest of assessing more objectives in less testing time. At Grade 10, this meant testing all pupils on 28 core objectives. A sampling procedure was used to assess student performance on 28 additional correlate objectives by means of four forms, each of which assessed 35 objectives: the 28

core objectives and seven correlate objectives.

Another significant change in the new version of the Grade 10 MEAP mathematics test was the criterion for success. The old (1979) version required four correct answers out of five for mastery; the new (1980) version required two correct answers out of three for mastery. Fourteen of the objectives assessed on the two versions were common. That is, the three items appearing on the 1980 version of the test for those 14 objectives had also appeared, along with one additional similar item, on the 1979 version. The remaining fourteen of the 28 core objectives on the 1980 version differed from the remaining 26 objectives assessed on the 1979 version.

MEAP data are reported in four categories which represent the percent of students achieving various percentages of objectives. These are: Category #1, 0-25% achieved; Category #2, 26-50% achieved; Category #3, 51-75% achieved; and Category #4, 76-100% achieved. Items for the 1980 version of the MEAP test were selected so as to produce similar proportions data on each version for students who participated in the item field test. That is, one goal of the item selection process was that classification of students in MEAP categories should be similar irrespective of the version of the test used.

Each of the objectives tested on the Grade 10 MEAP mathematics test is assigned to a skill area. The 1979 version tested ten skill areas: whole number division;

fractions; decimals; integers; ratio, proportion, percent; geometric measurement; non-geometric measurement; geometry; algebra; and probability and statistics. The 1980 version tested nine skill areas: whole number division; decimals; fractions; ratio, proportion, percent; metric measurement; non-metric measurement; geometry; probability and statistics; and equations, expressions, graphs. Lists of objectives tested on each version of the test, arranged by skill area, appear in Figure 1 (1979 version) and Figure 2 (1980 version).

The purpose of the study reviewed in this paper was to examine the factor structures of the two versions of the Grade 10 MEAP mathematics test. First, the factor structure of each version of the test was examined to determine to what extent it matched the skill area structure defined above. Second, factors from the two versions were matched using Gorsuch's (1974) procedure of examining correlations among factor scores. Third, the extent to which the extracted factors matched the skill areas was examined. Fourth, since there was a fourteen objective overlap in the two versions, the structure of the common objectives was examined in order to determine if objectives measured by the same items behave differently under different circumstances. Fifth, the remaining objectives from the two versions, 40 in all, were factor analyzed in order to examine the underlying factor structures and in order to determine whether the same unexpected

FIGURE 1

GRADE TEN MATHEMATICS
Old MEAP Test

Skill Areas and Objectives[a]
WHOLE NUMBER DIVISION:
Computation (O 1)
FRACTIONS:
Find a Set of Equivalent Fractions (O 2)
Find the Larger of Two Fractions (O 3)*
Add Mixed Numbers (O 4)
Subtract Fractions with Unlike Denominators (O 5)*
Subtract Mixed Numbers with Unlike Denominators (O 6)*
Multiply Fractions (O 7)*
Whole Number X Fraction (O 8)
Whole Number X Mixed Number (O 9)*
DECIMALS:
Round to Nearest 1, .1, .01 (O 10)
Convert Common Fraction to Decimal (O 11)
Order a Set of Decimals (O 12)*
Decimal X Whole Number Power of 10 (O 13)
Decimal X Decimal (O 14)*
Decimal Divided by Decimal (O 15)*
INTEGERS:
Locate Integers on a Number Line (O 16)
Add Integers (O 17)
RATIO, PROPORTION, PERCENT:
Write Ratio Describing Indicated Comparison (O 18)
Write Equivalent Ratio--Supply Whole Number (O 19)
Convert Fractions, Decimals, Percents (O 20)*
Determine Percentage of Given Number (O 21)
Word Problems--Find Percentage of a Number (O 22)*

(more)

FIGURE 1 (CONTINUED)

GRADE TEN MATHEMATICS
Old MEAP Test (Continued)

Skill Areas and Objectives[a]
GEOMETRIC MEASUREMENT:
Measure Object to Nearest Unit (O 23)
Find Perimeter of Polygons & Circles (O 24)
Word Problems--Standard Units of Measure (O 25)
Read a Coordinate System (O 26)*
Locate Items in a Table of Data (O 27)
Measure Triangle & Find Area (O 28)
Word Problems--Rectangles, Triangles, Circles (O 29)
NON-GEOMETRIC MEASUREMENT:
Find Difference in Time Intervals (O 30)
Given Cost, What Could be Purchased (O 31)
Multiply/Divide Money by Positive Integer (O 32)
GEOMETRY:
Identify Parts of a Circle (O 33)*
Identify Congruent & Non-Congruent Figures (O 34)
ALGEBRA:
Solve Linear Equation (O 35)
Write R**N as N Factors of R (O 36)
Evaluate Common Algebraic Expressions (O 37)*
PROBABILITY AND STATISTICS:
Answer Questions Using Bar Graph (O 38)
Predict Number of Times Event Will Occur (O 39)
Find the Mean of a Set of Numbers (O 40)

*These objectives were common to the old and new tests.

[a]As they appear on the proportions report forms for the old version of the Grade 10 MEAP mathematics test.

FIGURE 2

GRADE TEN MATHEMATICS
New MEAP Test

Skill Areas and Objectives[b]
WHOLE NUMBER DIVISION:
Computation (N 1)
Word Problems (N 2)
DECIMALS:
Convert Fractions to Decimals (N 3)
Order a Set of Decimals (N 4)*
Decimal X Decimal (N 5)*
Word Problems: Multiplication (N 6)
Decimal Divided by Whole Number (N 7)
Decimal Divided by Decimal (N 8)*
FRACTIONS:
Find the Larger of Two Fractions (N 9)*
Convert Mixed Numbers to Common Fractions (N 10)
Add Fractions with Unlike Denominators (N 11)
Addition Word Problems (N 12)
Subtract Fractions with Unlike Denominators (N 13)*
Subtract Mixed Numbers with Unlike Denominators (N 14)*
Multiply Fractions (N 15)*
Whole Number X Mixed Number (N 16)*
RATIO, PROPORTION, PERCENT:
Convert Fractions, Decimals, Percents (N 17)*
Word Problems--Find Percentage of a Number (N 18)*
METRIC MEASUREMENT:
Area Word Problems (N 19)
Volume Computation (N 20)
NON-METRIC MEASUREMENT:
Angle Measurement (N 21)
Time Conversion (N 22)
Money Word Problems (N 23)

(more)

FIGURE 2 (CONTINUED)
GRADE TEN MATHEMATICS
New MEAP Test (Continued)

Skill Areas and Objectives[b]
GEOMETRY:
Identify Parts of a Circle (N 24)*
PROBABILITY AND STATISTICS:
Probability of a Simple Event (N 25)
Find the Mean of a Set of Numbers (N 26)*
EQUATIONS, EXPRESSIONS, GRAPHS:
Evaluate Common Algebraic Expressions (N 27)*
Read a Coordinate System (N 28)*

*These objectives were common to the old and new tests.

[b]As they appear on the proportions report forms for the new version of the Grade 10 MEAP mathematics test.

results observed in the previous analyses carried over to these objectives as well. Finally, results of the two tests were examined using the MEAP criteria in order to ascertain whether decisions based upon the two versions of the test would result in the same or different classifications of students and/or schools.

Significance of the Study

Many important decisions are made at state and local school district levels based upon MEAP results. Longitudinal proportions data, indicating the proportion of students scoring in each of the four MEAP categories over three years, are used by the Michigan Department of Education to allocate state compensatory education funds. MEAP results are used at all levels as indicators of the level of achievement in basic skills for students and, as such, as indicators of the quality of basic skills education. When the MEAP test was revised in 1980, information used for these decisions included data generated from two different versions. The question of the comparability of the two versions became very important. If the two versions of the test were not comparable, longitudinal comparisons would not be appropriate.

The model developed in this study approached the comparability question from a non-traditional perspective. Early investigations of this issue, for the MEAP,

concentrated upon the classification of students, based upon their scores on the two versions, into MEAP categories. A high correlation between old and new version classification of students was judged to be sufficient, given the scrutiny to which items had been subjected prior to the initial field test. This study approached the issue by examining the factor structures of the two versions of the test followed by attempts to equate the resulting factors using correlations among factor scores. In other words, the two versions of the test were compared in terms of the traits they measured.

The results of this investigation reinforce the tenents that when the number of items per objective, configuration, testing conditions, number of objectives tested (length), and/or content of a test are changed, the test's structure is also changed. This became most obvious when the subset of objectives common to the two versions of the test were examined separately from the objectives which were not common to the two versions.

Findings

The subjects involved in this study were 557 Grade 10 students in five volunteer high schools in Michigan. The high schools selected represented five of the six major community types identified by the Michigan Department of Education: Southeast Metro, Outstate Metro, Outstate Rural, Southeast Suburb, Outstate Suburb, and Northern. Each of the

five schools administered the new version of the Grade 10 Michigan Educational Assessment Program mathematics test during the designated testing period (September, October, 1980) followed by the old version of the test approximately three weeks later. Data were collected by the Michigan Department of Education and the researcher had no control over the order of administration.

The instruments used in this study were two versions of the Michigan Educational Assessment Program Grade 10 mathematics test: the old (1979) version of the test and the new (1980) version of the test. Each of these instruments was an objective-referenced test which was written based upon sets of minimal performance objectives for students at the beginning of Grade 10. Members of the Michigan Council of Teachers of Mathematics were instrumental in writing the original set of mathematics objectives and also in editing and revising the items for both versions.

The old version assessed 40 objectives classified in ten skill areas. Each of the four forms of the new test assessed 35 objectives, 28 core objectives and 7 correlates. Only the 28 core objectives common to all four forms were included in the proportions report. Data from the proportions report were used as a basis for equating the two tests and for viewing longitudinal data on schools and school districts. The 28 core objectives on the new test were classified in nine skill areas.

Since these were objective-referenced instruments, traditional measures of validity and reliability were not appropriate and were not available. Due to the fact that the objectives and items for both instruments were thoroughly scrutinized by a large number of Michigan mathematics teachers in formal sessions where items were criticized and revised, however, it would seem appropriate to conclude that these instruments possessed a reasonable degree of content validity.

With respect to reliability of an objective-referenced instrument, it is generally accepted that the larger the number of items per objective the higher the reliability. Since the new version reduced the number of items per objective, this would appear to have been detrimental to the reliability of the instrument. Preliminary studies conducted by the Michigan Department of Education indicated that the proportions report classification for students on the old and new versions differed very little. These findings tended to support the reliability of the new test in terms of the old one.

Data were collected from five high schools located throughout the state. These schools volunteered to administer the old version of the Grade 10 MEAP mathematics test along with the regular administration of the new version of the MEAP test in the fall of 1980. Students at these five sites took all of the new Grade 10 MEAP test during the

state-wide administration of the test. They then took the mathematics portion of the old Grade 10 MEAP test approximately three weeks later. Completed answer sheets for both tests were forwarded to the scoring service for machine scoring. A computer tape containing individual pupil data for both instruments was produced from these answer sheets. A copy of this data tape was released to the researcher by the Michigan Department of Education.

The initial phase of this study involved a series of exploratory factor analyses. These analyses were conducted at the objective score level. For the old version of the test, four items were used to assess each objective. A score of 0 through 4 was assigned to each of the 40 objectives on the old test based upon the number of items answered correctly. Each subject had 40 scores, each ranging from 0 through 4. For the new version of the test, three items were used to assess each objective. A score of 0 through 3 was assigned to each of the 28 core objectives on the new test based upon the number of items answered correctly. Each subject had 28 scores, ranging from 0 through 3.

Each version of the test was then factor analyzed using principal components analysis with iterations followed by varimax rotation. Factor scores were computed for each of the 557 subjects on each of the two versions of the test.

Table 1 presents the rotated factor matrix for the new version of the test. The objectives are listed according to

TABLE 1

ROTATED FACTOR MATRIX
NEW (1980) GRADE 10 MEAP MATHEMATICS TEST
ALL OBJECTIVES

Objectives	Factors**		
	I	II	III
FRACTIONS: ADD FRACTIONS WITH UNLIKE DENOMINATORS (N 11)	.68207	.18119	.24833
FRACTIONS: ADDITION WORD PROBLEMS (N 12)	.65086	.21991	.18231
FRACTIONS: SUBTRACT MIXED NUMBERS UNLIKE DENOMINATORS (N 14)*	.60874	.29675	.34516
FRACTIONS: SUBTRACT FRACTIONS UNLIKE DENOMINATORS (N 13)*	.57055	.20217	.43425
FRACTIONS: WHOLE NUMBER X MIXED NUMBER (N 16)*	.52681	.23048	.12772
EQUATIONS EXP GRAPHS: EVALUATE COMMON ALG EXP (N 27)*	.48970	.43525	.38357
METRIC MEAS: AREA WORD PROBLEMS (N 19)	.46982	.35127	.16363
FRACTIONS: CONVERT MIXED NOS. TO COMMON FRACTIONS (N 10)	.45452	.42982	.28537
METRIC MEAS: VOLUME COMPUTATION (N 20)	.43472	.25905	.39841
NON-METRIC MEAS: ANGLE MEASUREMENT (N 21)	.39261	.36565	.12925
GEOMETRY: PARTS OF A CIRCLE (N 24)*	.36054	.24216	.25875
FRACTIONS: MULTIPLY FRACTIONS (N 15)*	.13412	.59788	.27724
DECIMALS: WORD PROBLEMS, MULTIPLICATION (N 6)	.32453	.58079	.34172
RATIO PROP I: WORD PROBLEM--FIND PERCENTAGE OF A NUMBER (N 18)*	.40609	.57036	.22358
DECIMALS: ORDER SET OF DECIMALS (N 4)*	.21875	.55742	.26864
NON-METRIC MEAS: MONEY WORD PROBLEMS (N 23)	.28543	.53964	.23395
DECIMALS: DECIMAL DIVIDED BY WHOLE NUMBER (N 7)	.43957	.51067	.30974
PROB & STAT: FIND THE MEAN OF A SET OF NUMBERS (N 25)*	.31977	.47217	.37118

TABLE 1--Continued

Objectives	Factors** I	II	III
PROB & STAT: PROBABILITY OF A SIMPLE EVENT (N 25)	.41772	.42062	.30830
DECIMALS: DECIMAL DIVIDED BY DECIMAL (N 8)*	.33441	.37308	.23686
WHOLE NUMBER DIVISION: WORD PROBLEMS (N 2)	.24401	.38531	.64759
WHOLE NUMBER DIVISION: COMPUTATION (N 1)	.12476	.43492	.59289
NON-METRIC MEAS: TIME CONVERSION (N 22)	.35457	.24763	.58591
DECIMALS: CONVERT FRACTIONS TO DECIMALS (N 3)	.50720	.20356	.53563
EQUATIONS EXP GRAPHS: READ A COORDINATE SYSTEM (N 28)*	.21111	.29887	.51888
DECIMALS: DECIMAL X DECIMAL (N 5)*	.21384	.46367	.50585
FRACTIONS: FIND THE LARGER OF TWO FRACTIONS (N 9)*	.43826	.23482	.45030
RATIO PROP I: CONVERT FRACTIONS DECIMALS PERCENTS (N 17)*	.35642	.19781	.44037

*These objectives appeared on both forms.

**Objectives are arranged according to factor loadings. The highest factor loading for each objective is contained in a rectangle.

factor loadings; that is, all objectives loading on Factor I are listed first in descending order of magnitude of factor loading followed by objectives loading on Factor II, and so on.

Factor I was identified as Fractions, Algebraic Operations and Formulas. The objectives with the highest loadings on Factor I were: adding fractions with different denominators, addition word problems, subtract mixed numbers with unlike denominators, subtract fractions with unlike denominators, whole numbers times mixed numbers, evaluate common algebraic expressions, area word problems, convert mixed numbers to common fractions, volume computations, angle measurement, and parts of a circle.

Factor II was identified as Decimals. The objectives with the highest loadings on Factor II were: multiply fractions, word problems: multiplication of decimals, word problems: find percentage of a given number, order a set of decimals, money word problems, decimal divided by a whole number, find the mean of a set of numbers, probability of a simple event, and decimal divided by a decimal.

Factor III was identified as Division. The objectives with the highest loadings on Factor III were: word problems: whole number division; computation: whole number division; time conversion; convert fractions to decimals; read a coordinate system; decimal times a decimal; find the larger of two fractions; and convert fractions, decimals, percents.

Table 2 presents the rotated factor matrix for the old version of the test. Like Table 1, the objectives are listed according to factor loadings.

Factor I was identified as Arithmetic: Whole Number and Decimal Multiplication and Division. The objectives with the highest loadings on Factor I were: answer questions using a bar graph; decimal times a decimal; word problems: standard units of measure; given cost, what could be purchased; whole number division: computation; find the larger of two fractions; convert common fractions to decimals; determine the percentage of a given number; word problems: rectangles, triangles, circles; parts of a circle; and find a set of equivalent fractions.

Factor II was identified as Algebraic Operations and Fractions. The objectives with the highest loadings on Factor II were: add mixed numbers; subtract mixed numbers; evaluate common algebraic expressions; decimal times a power of ten; whole number times a fraction; locate integers on a number line; solve linear equations; find the mean of a set of numbers; whole number times a mixed number; decimal divided by a decimal; add integers; write exponential expression as a product; and round to the nearest one, tenth, hundredth.

Factor III was identified as Ratio, Proportion and Probability. The objectives with the highest loadings on Factor III were: multiply or divide money by a positive

TABLE 2

ROTATED FACTOR MATRIX
OLD (1979) GRADE 10 MEAP MATHEMATICS TEST
ALL OBJECTIVES

Objectives	Factors**				
	I	II	III	IV	V
PROB & STAT: ANSWER QUESTIONS USING BAR GRAPH (O 38)	.69570	.17874	.23064	.19003	.25049
DECIMALS: DECIMAL X DECIMAL (O 14)*	.65964	.26572	.31172	.09254	.05090
GEOM MEAS: WORD PROBLEM--STANDARD UNITS OF MEASURE (O 25)	.65071	.28309	.22263	.33798	.07498
NON-GEOM MEAS: GIVEN COST, WHAT COULD BE PURCHASED (O 31)	.63351	.13861	.45300	.05250	.22858
WHOLE NUMBER DIVISION: COMPUTATION (O 1)	.63184	.33651	.42878	-.00910	.11415
FRACTIONS: FIND THE LARGER OF TWO FRACTIONS (O 3)*	.60212	.29178	.17709	.29188	.15650
DECIMALS: CONVERT COMMON FRACTION TO DECIMAL (O 11)	.57312	.35902	.14318	.37132	.05915
RATIO PROP I: DETERMINE PERCENTAGE OF GIVEN NUMBER (O 21)	.53159	.21626	.25626	.24743	.05117
GEOM MEAS: WORD PROB--RECTANGLES, TRIANGLES, CIRCLES (O 29)	.51698	.30968	.16026	.35747	.05476
GEOMETRY: PARTS OF A CIRCLE (O 33)*	.51035	.17612	.34539	.28867	.08532
FRACTIONS: FIND A SET OF EQUIVALENT FRACTIONS (O 2)	.45492	.35611	.36696	.21485	.08334
FRACTIONS: ADD MIXED NUMBERS (O 4)	.21277	.71981	.08940	.17981	.09669
FRACTIONS: SUBTRACT MIXED NUMBERS UNLIKE DENOMINATORS (O 6)*	.20306	.70389	.14209	.09812	.02163
FRACTIONS: SUBTRACT FRACTIONS UNLIKE DENOMINATORS (O 5)*	.53462	.57477	.27719	.04296	.07768
ALGEBRA: EVALUATE COMMON ALG EXP (O 37)*	.28031	.56016	.11892	.37452	.26930
DECIMALS: DECIMAL X WHOLE NO. POWER OF 10 (O 13)	.22533	.50817	.32719	.18679	.08372

TABLE 2--Continued

Objectives	Factors**				
	I	II	III	IV	V
FRACTIONS: WHOLE NUMBER X FRACTION (O 8)	.23046	.49764	.21233	.15446	.10809
INTEGERS: LOCATE INTEGERS ON A NUMBER LINE (O 16)	.16615	.48817	.07674	.27785	.34725
ALGEBRA: SOLVE LINEAR EQUATION (O 35)	.10594	.47668	.17249	.22973	.23323
PROB & STAT: FIND THE MEAN OF A SET OF NUMBERS (O 40)*	.12996	.44965	.15676	.19107	.20797
FRACTIONS: WHOLE NUMBER X MIXED NUMBER (O 9)*	.27943	.44681	.18075	.27446	-.04458
DECIMALS: DECIMAL DIVIDED BY DECIMAL (O 15)*	.27088	.43991	.39219	.17599	.02262
INTEGERS: ADD INTEGERS (O 17)	.26684	.43870	.10029	.39430	.22406
ALGEBRA: WRITE R**N AS N FACTORS OF R (O 36)	.16508	.39130	.35132	.08003	.23012
DECIMALS: ROUND TO NEAREST 1, .1, .01 (O 10)	.22900	.36429	.19264	.27599	.33719
NON-GEOM MEAS: MULTIPLY/DIVIDE MONEY BY POS INTEGER (O 32)	.23137	.21318	.74306	-.04296	.11656
GEOM MEAS: READ A COORDINATE SYSTEM (O 26)*	.15811	.11388	.70933	.08808	.19083
RATIO PROP %: WRITE RATIO DESCRIBING INDICATED COMPARISON (O 18)	.22173	.07539	.69274	.09157	.10496
GEOM MEAS: LOCATE ITEMS IN A TABLE OF DATA (O 27)	.54018	.05343	.57363	-.00574	.25972
DECIMALS: ORDER A SET OF DECIMALS (O 12)*	.27440	.16279	.55408	.26866	.11957
RATIO PROP %: CONVERT FRACTIONS DECIMALS PERCENTS (O 20)*	.29470	.26860	.54195	.28509	.05550
PROB & STAT: PREDICT NUMBER OF TIMES EVENT WILL OCCUR (O 39)	.21977	.29015	.54053	.41328	.12329
RATIO PROP %: WORD PROBLEM--FIND PERCENTAGE OF A NUMBER (O 22)*	.32283	.24770	.50762	.35391	.05041

TABLE 2--Continued

Objectives	Factors** I	II	III	IV	V
GEOM MEAS: FIND PERIMETER OF POLYGONS AND CIRCLES (O 24)	.31492	.38330	.30115	.52220	.08194
RATIO PROP I: WRITE EQUIVALENT RATIO--SUPPLY WHOLE NUMBER (O 19)	.20890	.29205	.07147	.48578	.10894
GEOM MEAS: MEASURE OBJECT TO NEAREST UNIT (O 23)	.16129	.36502	.06500	.46138	.18586
GEOM MEAS: MEASURE TRIANGLE & FIND AREA (O 28)	.33782	.34745	.06337	.36761	-.02210
GEOMETRY: IDENTIFY CONGRUENT & NON-CONGRUENT FIGURES (O 34)	.10765	.14764	.34916	.14909	.52069
NON-GEOM MEAS: FIND DIFFERENCE IN TIME INTERVALS (O 30)	.13406	.36188	.31931	.25206	.42660
FRACTIONS: MULTIPLY FRACTIONS (O 7)*	.15571	.19187	.38261	-.05730	.39835

*These objectives appeared on both forms.

**Objectives are arranged according to factor loadings. The highest factor loading for each objective is contained in a rectangle.

integer; read a coordinate system; write a ratio describing an indicated comparison; locate items in a table of data; order a set of decimals; convert fractions, decimals, percents; predict number of times an event will occur; and word problems: find percentage of a number.

Factor IV was identified as Metric Measurement. The objectives with the highest loadings on Factor IV were: find the perimeter of polygons and circles; write equivalent ratios by supplying the missing whole number; measure objects to nearest unit; and measure triangle and find area.

Factor V was identified as Non-Metric Measurement. The objectives with the highest loadings on Factor V were: identify congruent and noncongruent figures, find the difference in time intervals, and multiply fractions.

Following each of the factor analyses described above, factor scores were computed for each of the 557 subjects based upon the three factors extracted from the new version of the test and the five factors extracted from the old version of the test. Pearson product-moment correlation coefficients were computed on all pairs of sets of factor scores in order to match factors using the procedure described by Gorsuch (1974). The resulting correlation matrix appears in Table 3.

The highest intercorrelation was between Factor I from the new version of the test, Fractions, Algebraic Operations and Formulas, and Factor II from the old version of the test,

TABLE 3

SUMMARY OF THE INTERCORRELATIONS AMONG FACTOR SCORES ON THE OLD (1979) AND NEW (1980) VERSIONS OF THE GRADE 10 MEAP MATHEMATICS TEST

Old (1979) Version Factors	New (1980) Version Factors		
	Factor I	Factor II	Factor III
Factor I	0.3214	0.2944*	0.1847
Factor II	0.6460*	0.2234	0.3854*
Factor III	0.0798	0.2792*	0.1717
Factor IV	0.4102*	0.1443	0.1871
Factor V	0.0534	0.0885	0.3096*

*Asterisks indicate the highest intercorrelations among factor scores.

Algebraic Operations and Fractions (r=+.6460), indicating a match between these two factors. Other intercorrelations were statistically significant but of such low magnitude as to be considered insignificant in the practical sense. It is also of interest to note that only one objective which was common to the two versions of the test, parts of a circle, loaded on both of these factors.

The next step in the analysis of these two versions of the MEAP mathematics test involved comparing the factor structure of each version to the MEAP skill areas. Figure 3 presents the distribution of the objectives from the new version of the test by skill area and factor loading. Objectives from four skill areas: Whole Numbers, Metric Measurement, Geometry, and Probability and Statistics loaded

FIGURE 3

DISTRIBUTION OF OBJECTIVES[a] FROM THE NEW (1980) VERSION OF THE GRADE 10 MEAP MATHEMATICS TEST BY SKILL AREA AND FACTOR LOADING

Skill Areas	Factors		
	I	II	III
	Fractions, Algebraic Operations and Formulas	Decimals	Division
Whole Numbers			2, 1
Decimals		6, 4, 7, 8	3, 5
Fractions	11, 12, 14, 13, 16, 10	15	9
Ratio, Proportion, Percent		18	17
Metric Measurement	19, 20		
Non-Metric Measurement	21	23	22
Geometry	24		
Probability and Statistics		26, 25	
Equations, Expressions and Graphs	27		28

[a]Numbers in the body of the figure refer to objective numbers listed in Figure 2.

on single factors. This would seem to indicate that these four skill areas encompassed objectives which measured a single trait. Six of the eight objectives in the Fractions skill area and four of the six objectives in the Decimals skill area loaded on a single factor indicating a moderate amount of consistency. The remaining skill areas: Ratio, Proportion, Percent; Non-Metric Measurement; and Equations, Expressions and Graphs had scattered factor loadings.

Figure 4 presents a similar distribution for the old version of the test. Objectives from three skill areas: Whole Number Division, Integers, and Algebra loaded on single factors. This would seem to indicate that these three skill areas encompassed objectives which measured a single trait. The Fractions skill area was almost evenly split between Factor I, Arithmetic: Whole Number and Decimal Multiplication and Division, and Factor II, Algebraic Operations and Fractions. The remaining six skill areas showed factor loadings scattered among several factors.

From these results it may be concluded that the skill area classifications for the two versions of the Grade 10 MEAP mathematics test do not represent groups of objectives which measure single traits. There were only three factors extracted from the new version of the test yet there are nine skill areas on this version. Similarly, there were five factors extracted from the old version which purports to measure ten skill areas. On the other hand, the objectives

FIGURE 4

DISTRIBUTION OF OBJECTIVES[a] FROM THE OLD (1979) VERSION OF THE GRADE 10 MEAP MATHEMATICS TEST BY SKILL AREA AND FACTOR LOADING

Skill Areas	Factor I Arithmetic: Whole Number and Decimal Multiplication and Division	Factor II Algebraic Operations and Fractions	Factor III Ratio, Proportion and Probability	Factor IV Metric Measurement	Factor V Non-Metric Measurement
Whole Number Division	1				
Fractions	3, 2, 4	6, 5, 8, 9			7
Decimals	14, 11	13, 15, 10	12		
Integers		16, 17			
Ratio, Proportion, Percent	21		18, 20, 22	19	
Geometric Measurement	25, 29		26, 27	24, 23, 28	
Non-Geometric Measurement	31		32		30
Geometry	33				34
Algebra		37, 35, 36			
Probability and Statistics	38	40	39		

[a]Numbers in the body of the figure refer to objective numbers listed in Figure 1.

assigned to a single skill area tended to load, in most cases, on more than one factor.

In order to explore the structure of the set of 14 objectives which were assessed on both versions of the Grade 10 MEAP mathematics test outside of the influence of the remaining objectives on each version, these 28 objective scores for each subject were factor analyzed separately. Table 4 presents the rotated factor matrix for these 28 objectives. The objectives are listed according to factor loadings; that is, all objectives loading on Factor I are listed first in descending order of magnitude of factor loading followed by objectives loading on Factor II, and so on. Objectives from the old version are numbered with O's. Objectives from the new version are numbered with N's.

Factor I was identified as Decimals and Percents (New Test) since most of the objectives loading on this factor were from the new version. The objectives with the highest loadings on Factor I were: decimal times a decimal; find the mean of a set of numbers; multiply fractions; order a set of decimals; read a coordinate system; word problems--find percentage of a given number; decimal divided by a decimal; find the larger of two fractions; convert fractions, decimals, percents; parts of a circle (all from the new version of the test); and find the mean of a set of numbers (from the old version of the test).

TABLE 4

ROTATED FACTOR MATRIX
14 PAIRS OF COMMON OBJECTIVES
OLD (1979) AND NEW (1980) GRADE 10 MEAP MATHEMATICS TESTS
NO RECODING

Objectives	Factors*			
	I	II	III	IV
DECIMALS: DECIMAL X DECIMAL (N 5)	.64736	.20398	.24220	.07079
PROB & STAT: FIND THE MEAN OF A SET OF NUMBERS (N 26)	.62701	.13917	.23461	.20182
FRACTIONS: MULTIPLY FRACTIONS (N 15)	.58972	.17308	.11698	.07577
DECIMALS: ORDER SET OF DECIMALS (N 4)	.57006	.21158	.08871	.18520
EQUATIONS EXP GRAPHS: READ A COORDINATE SYSTEM (N 28)	.51329	.20472	.16664	.09031
RATIO PROP %: WORD PROBLEM--FIND PERCENTAGE OF A NUMBER (N 18)	.51058	.20977	.21451	.37297
DECIMALS: DECIMAL DIVIDED BY DECIMAL (N 8)	.44554	.22044	.28354	.06947
FRACTIONS: FIND THE LARGER OF TWO FRACTIONS (N 9)	.43818	.14868	.32986	.33299
RATIO PROP %: CONVERT FRACTIONS DECIMALS PERCENTS (N 17)	.42557	.22817	.26757	.12675
PROB & STAT: FIND THE MEAN OF A SET OF NUMBERS (O 40)	.38779	.20854	.26389	.21372
GEOMETRY: PARTS OF A CIRCLE (N 24)	.35524	.07728	.22477	.28943
GEOM MEAS: READ A COORDINATE SYSTEM (O 26)	.17417	.69462	.07186	.02423
DECIMALS: ORDER A SET OF DECIMALS (O 12)	.19058	.65931	.11343	.16981
RATIO PROP %: CONVERT FRACTIONS DECIMALS PERCENTS (O 20)	.19117	.63974	.27862	.14927
RATIO PROP %: WORD PROBLEM--FIND PERCENTAGE OF A NUMBER (O 22)	.19355	.59594	.17065	.34477
DECIMALS: DECIMAL X DECIMAL (O 14)	.22071	.46340	.28324	.36030
DECIMALS: DECIMAL DIVIDED BY DECIMAL (O 15)	.31108	.45650	.31930	.16684
GEOMETRY: PARTS OF A CIRCLE (O 33)	.19364	.45346	.19956	.42472

TABLE 4--Continued

Objectives	Factors*			
	I	II	III	IV
FRACTIONS: MULTIPLY FRACTIONS (O 7)	.19279	.40383	.13747	.01829
FRACTIONS: SUBTRACT MIXED NUMBERS UNLIKE DENOMINATORS (O 6)	.19637	.19991	.72769	.10946
FRACTIONS: SUBTRACT MIXED NUMBERS UNLIKE DENOMINATORS (N 14)	.39635	.20693	.66104	.15731
FRACTIONS: SUBTRACT FRACTIONS UNLIKE DENOMINATORS (N 13)	.37470	.12110	.65829	.18651
FRACTIONS: SUBTRACT FRACTIONS UNLIKE DENOMINATORS (O 5)	.18282	.43202	.61418	.26296
FRACTIONS: WHOLE NUMBER X MIXED NUMBER (O 9)	.18669	.24146	.44996	.25639
FRACTIONS: WHOLE NUMBER X MIXED NUMBER (N 16)	.26585	.15455	.40811	.21001
EQUATIONS EXP GRAPHS: EVALUATE COMMON ALG EXP (N 27)	.48845	.18718	.34264	.52288
FRACTIONS: FIND THE LARGER OF TWO FRACTIONS (O 3)	.18757	.40688	.32436	.48184
ALGEBRA: EVALUATE COMMON ALG EXP (O 37)	.32387	.25711	.38267	.46951

*Objectives are arranged according to factor loadings. The highest factor loading for each objective is contained in a rectangle.

Factor II was identified as Decimals and Percents (Old Test) since all of the objectives loading on this factor were from the old version. The objectives with the highest loadings on Factor II were: read a coordinate system; order a set of decimals; convert fractions, decimals, percents; word problems--find percentage of a given number; decimal times a decimal; decimal divided by a decimal; parts of a circle; and multiply fractions.

Factor III was identified as Fractions. This factor was defined by three sets of two objectives: subtract mixed numbers (both objectives), subtract fractions (both objectives), and whole number times a mixed number (both objectives).

Factor IV was identified as Algebra. The objectives with high loadings on Factor IV were: evaluate common algebraic expressions (both the old and new version), and find the larger of two fractions (from the old version).

Examination of these results reveals an unexpected pattern: objectives were more likely to load on a factor which was characterized by the version of the test on which the objectives appeared than to load with the corresponding objective from the other version of the test which consisted of three identical items on the two versions with one additional similar item on the old version of the test. Only Factor III, Fractions, behaved in the expected manner. That is, the Fractions factor was defined by three old version

objectives and their three new version counterparts. Factor IV, Algebra, came close to the expectation with one pair of objectives loading on it. An additional objective from the old version also loaded on this factor with the corresponding objective from the new version loading on Factor I, Decimals and Percents (New Test).

A further investigation of this phenomenon was undertaken by factor analyzing the set of 40 objectives which were not common to the two versions of the test in order to determine if these objectives would load in a similar pattern. Table 5 presents the rotated factor matrix for these 40 objectives (14 from the new version of the test, 26 from the old version of the test). The objectives are listed according to factor loadings; that is, all objectives loading on Factor I are listed first in descending order of magnitude of factor loading followed by objectives loading on Factor II, and so on. Objectives from the old version are numbered with O's. Objectives from the new version are numbered with N's.

Factor I was identified as Word Problems. All objectives loading on Factor I were from the new version of the test. They were: whole number division--word problems; whole number division--computation; multiplication of decimals--word problems; decimal divided by a whole number; time conversion; money word problems; convert mixed number to common fraction; probability of a simple event; and volume

TABLE 5

ROTATED FACTOR MATRIX
40 OBJECTIVES NOT COMMON TO THE
OLD (1979) AND NEW (1980) GRADE 10 MEAP MATHEMATICS TESTS
NO RECODING

Objectives	Factors*					
	I	II	III	IV	V	VI
WHOLE NUMBER DIVISION: WORD PROBLEMS (N 2)	.68685	.34709	.11964	.16503	.12551	-.06211
WHOLE NUMBER DIVISION: COMPUTATION (N 1)	.68205	.13068	.07080	.17318	.12537	-.01354
DECIMALS: WORD PROBLEMS, MULTIPLICATION (N 6)	.61227	.18477	.23531	.14173	.11525	.14402
DECIMALS: DECIMAL DIVIDED BY WHOLE NUMBER (N 7)	.58051	.17387	.30836	.15869	.17558	.25250
NON-METRIC MEAS: TIME CONVERSION (N 22)	.51264	.49700	.18256	.08798	.15169	-.10050
NON-METRIC MEAS: MONEY WORD PROBLEMS (N 23)	.50596	.10199	.23994	.20171	.13760	.10461
FRACTIONS: CONVERT MIXED NOS. TO COMMON FRACTIONS (N 10)	.50267	.19990	.26557	.18614	.20505	.18847
PROB & STAT: PROBABILITY OF A SIMPLE EVENT (N 25)	.48140	.22705	.40059	.08640	.13489	-.01402
METRIC MEAS: VOLUME COMPUTATION (N 20)	.40892	.32759	.30146	.06875	.21722	.07740
INTEGERS: LOCATE INTEGERS ON A NUMBER LINE (O 16)	.18847	.59574	.17757	.11068	.15332	.18099
NON-GEOM MEAS: FIND DIFFERENCE IN TIME INTERVALS (O 30)	.19411	.55377	.14870	.35018	.12774	-.01282
INTEGERS: ADD INTEGERS (O 17)	.19416	.49407	.32382	.12040	.23040	.12837
DECIMALS: ROUND TO NEAREST 1, .1, .01 (O 10)	.19091	.48983	.16920	.19663	.26357	.00788
ALGEBRA: SOLVE LINEAR EQUATION (O 35)	.25427	.48333	.11323	.15746	.11271	.22114
GEOM MEAS: MEASURE OBJECT TO NEAREST UNIT (O 23)	.16935	.47519	.38912	.04871	.12839	-.00830
DECIMALS: CONVERT FRACTIONS TO DECIMALS (N 3)	.44033	.45950	.31570	.06006	.21010	.05128
FRACTIONS: ADD MIXED NUMBERS (O 4)	.32040	.45212	.35193	.09591	.12138	.33883

TABLE 5--Continued

Objectives	Factors*					
	I	II	III	IV	V	VI
FRACTIONS: WHOLE NUMBER X FRACTION (O 8)	.24023	.34774	.20411	.18088	.22544	.28382
ALGEBRA: WRITE R**N AS N FACTORS OF R (O 36)	.21514	.34605	.08349	.34034	.16553	.20327
METRIC MEAS: AREA WORD PROBLEMS (N 19)	.28772	.10913	.58736	.08750	.22836	.02058
GEOM MEAS: MEASURE TRIANGLE & FIND AREA (O 28)	.12417	.18802	.54877	.04774	.27367	.13628
GEOM MEAS: WORD PROBLEM--RECTANGLES, TRIANGLES, CIRCLES (O 29)	.14974	.21809	.50424	.17709	.43852	.08746
GEOM MEAS: FIND PERIMETER OF POLYGONS & CIRCLES (O 24)	.15939	.43104	.47512	.28354	.25725	.02970
NON-METRIC MEAS: ANGLE MEASUREMENT (N 21)	.27900	.10988	.47275	.13879	.07358	.01012
FRACTIONS: ADDITION WORD PROBLEMS (N 12)	.31806	.27677	.46699	.12623	.03116	.26508
FRACTIONS: ADD FRACTIONS WITH UNLIKE DENOMINATORS (N 11)	.35581	.28470	.45778	.09872	.07688	.26706
RATIO PROP I: WRITE EQUIVALENT RATIO--SUPPLY WHOLE NUMBER (O 19)	.15331	.36222	.43425	.09093	.14845	-.07378
NON-GEOM MEAS: MULTIPLY/DIVIDE MONEY BY POS INTEGER (O 32)	.16215	.10569	.07117	.74494	.17371	.16331
RATIO PROP I: WRITE RATIO DESCRIBING INDICATED COMPARISON (O 18)	.10533	.09866	.12197	.68097	.16831	.03459
GEOM MEAS: LOCATE ITEMS IN A TABLE OF DATA (O 27)	.18354	.09831	.05354	.63174	.47055	-.02533
PROB & STAT: PREDICT NUMBER OF TIMES EVENT WILL OCCUR (O 39)	.16545	.38000	.30924	.49988	.20044	-.01392
GEOMETRY: IDENTIFY CONGRUENT & NON-CONGRUENT FIGURES (O 34)	.14794	.38177	.09139	.41767	.07694	-.11596
DECIMALS: DECIMAL X WHOLE NO. POWER OF 10 (O 13)	.19812	.31489	.28178	.32266	.19276	.30103

TABLE 5—Continued

Objectives	Factors*					
	I	II	III	IV	V	VI
PROB & STAT: ANSWER QUESTIONS USING BAR GRAPH (O 38)	.19400	.24281	.23217	.29345	.62985	-.04178
NON-GEOM MEAS: GIVEN COST, WHAT COULD BE PURCHASED (O 31)	.21220	.15935	.07448	.50822	.60524	.01444
WHOLE NUMBER DIVISION: COMPUTATION (O 1)	.23858	.17757	.10705	.45977	.59960	.20398
DECIMALS: CONVERT COMMON FRACTION TO DECIMAL (O 11)	.21627	.31888	.38998	.10326	.55483	.08165
GEOM MEAS: WORD PROBLEM--STANDARD UNITS OF MEASURE (O 25)	.18420	.24259	.43139	.25766	.55236	.02432
RATIO PROP I: DETERMINE PERCENTAGE OF GIVEN NUMBER (O 21)	.11935	.16735	.31000	.25020	.50807	.10222
FRACTIONS: FIND A SET OF EQUIVALENT FRACTIONS (O 2)	.21115	.23506	.32699	.37714	.39059	.14647

*Objectives are arranged according to factor loadings. The highest factor loading for each objective is contained in a rectangle.

computation.

Factor II was identified as Algebra. All but one of the objectives defining Factor II were from the old version: locate integers on a number line; find the difference in time intervals; add integers; round to the nearest one, tenth, or hundredth; solve linear equations; measure an object to the nearest unit; add mixed numbers; whole number times a fraction; and write exponents as the product of factors. The one new version objective loading on this factor was convert fractions to decimals.

Factor III was identified as Using Standard Units of Measure. This factor was defined by four new version objectives (area word problems; angle measurement; addition of fractions--word problems; and add fractions) and four old version objectives (measure a triangle and find the area; word problems--rectangles, triangles, circles; find the perimeter of polygons and circles; and write equivalent ratios by supplying the missing whole number).

Factor IV was identified as Non-Metric Measurement. This factor was defined entirely by objectives from the old version: multiply or divide money by a positive integer; write a ratio describing an indicated comparison; locate items in a table of data; predict the number of times an event will occur; identify congruent and noncongruent figures; and multiply a decimal by a whole number power of ten.

Factor V was identified as Using Charts and Graphs. Factor V was defined entirely by old version objectives: answer questions using a bar graph; given the cost, what could be purchased; whole number division--computation; convert common fractions to decimals; word problems--standard units of measure; determine percentage of a given number; and find a set of equivalent fractions.

Factor VI had no significant loadings.

The examination of these 40 objectives confirmed the results observed in the 14 pairs of objectives described above. That is, objectives tended to load on factors which were characterized by the version of the test on which the objectives appeared. For example, Factor I, Word Problems, was entirely defined by new version objectives and Factor II, Algebra, was defined by ten objectives from the old version and one from the new version. Factor IV, Non-Metric Measurement, and Factor V, Using Charts and Graphs, were both entirely defined by objectives from the old version. Only Factor III, Using Standard Units of Measure, could be described as a combination factor; that is, it was defined by half old version and half new version objectives.

Three attempts were made to account for this unusual pattern by recoding the objective scores in order to equalize the score distributions. None of these attempts was successful. In each case, although the configuration of the factor spaces changed slightly, the tendency of objectives to group

by test version over content persisted.*

The final phase of the research described in this paper involved an investigation of the decisions which would result from the use of each of the two versions of the test. The importance of the observed differences in factor structure are less important if it can be demonstrated that MEAP based decisions are essentially the same regardless of which version of the test is used. Since the same individuals took both versions of the test within a three-week period, examination of proportions data for this sample should reveal to what extent the same decision would be made from each version of the test.

To that end, a proportions report was compiled for the entire sample of 557 students based upon six sets of items: 14 common objectives from the old version, 14 common objectives from the new version, 26 objectives from the old version which did not appear on the new version, 14 objectives from the new version which did not appear on the old version, the entire old version (40 objectives), and the entire new version (28 objectives). These data appear in Table 6.

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*Results of these analyses may be found in JoAnne E. Moore (1983).

TABLE 6

PROPORTIONS REPORTS BASED UPON SIX SETS OF ITEMS
GRADE 10 MEAP MATHEMATICS TESTS (N = 557)

Item Set	MEAP Category*							
	1		2		3		4	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Old Test -- 14 Common	82	14.7%	164	29.4%	125	22.4%	186	33.4%
New Test -- 14 Common	56	10.1	139	25.0	122	21.9	240	43.1
Old Test -- 26 Different	77	13.8	157	28.2	175	31.4	148	26.6
New Test -- 14 Different	76	13.6	135	24.2	124	22.3	222	39.9
Old Test -- All 40	88	15.8	141	25.3	158	28.4	170	30.5
New Test -- All 28	63	11.3	135	24.2	141	25.3	218	39.1

*MEAP categories are based upon the percent of objectives achieved:

Category 1: 0% - 25%
Category 2: 26% - 50%
Category 3: 51% - 75%
Category 4: 76% - 100%

Examination of these data confirms the differences observed in the factor analyses. The students in the sample were classified as higher achievers on the new version of the test than they were on the old version. This is most remarkable in the case of the 14 objectives which were common to the two versions of the test. All 557 students in the sample took the new version of the test first, followed approximately three weeks later by the old version. For these 14 common objectives, all students had previously worked three of the four items which appeared on the old version. Even so, 9.7% fewer students were classified in Category #4 on the old version of the test for these 14 objectives.

Examination of the objectives which were not common to the two forms produced even larger differences: 13.3% more of the students were classified in Category #4 on the new version subset of objectives. When the two versions were examined in their entirety, the discrepancy in classification persisted.

The conclusion reached based upon these data was that students taking the new version were more likely to score in Category #4 than those taking the old version of the test. This result has serious implications for decisions made based upon longitudinal data from the MEAP where the two versions of the test are involved.

Conclusions

The major conclusion of the study reported in this paper was that the old (1979) and new (1980) versions of the Grade 10 MEAP mathematics test differ in factor structure and in the classification of pupils into MEAP categories. The old version measured five factors: I. Arithmetic: Whole Number and Decimal Multiplication and Division; II. Algebraic Operations and Fractions; III. Ratio, Proportion, and Percent; IV. Metric Measurement; and V. Non-Metric Measurement. The new version measured three factors: I. Fractions, Algebraic Operations, and Formulas; II. Decimals; and III. Division. When factor scores for all subjects were computed on each of these factors and subsequently correlated, only Factor I from the new version: Fractions, Algebraic Operations and Formulas, and Factor II from the old version: Algebraic Operations and Formulas were correlated at a level of practical significance (r=+.6460). This indicated that different traits were being assessed on the two versions.

The two versions shared a set of 14 objectives which were assessed on both using three identical items with a fourth similar item appearing on the old version. These 28 objectives were factor analyzed separately. The results indicated that objectives were more likely to load on factors according to the version of the test on which they appeared than to load in pairs which were matched based upon a common

set of three items. This phenomenon was confirmed when the remaining 40 objectives from the two versions were factor analyzed together. Several attempts to account for this unexpected behavior by rescaling the objective scores were made but no significant improvement was observed.

The implication of these findings is that the two versions of the Grade 10 MEAP mathematics test do not measure the same traits--even when the same items are used in a different configuration. Guertin (1954) suggested that the order of presentation of items resulted in significantly different scores on the Wechsler-Bellevue Arithmetic subtest. A similar situation seems to have occurred in this study. Practice effect must be ruled out as an explanation since students performed better the first time the items were presented than they did the second time. Student fatigue and the possibility of less than optimal testing conditions are possible competing hypotheses over which the researcher had no control.

With respect to the classification of pupils, the new version tended to classify students as achieving in significantly higher categories than the old version.

To summarize, when an objective-referenced, state-wide assessment test is significantly revised, caution should be exercised in making comparisons across versions of the test. Even when the same items are used on both versions, the fact that they appear in a different configuration may mean that

they are assessing different traits and the results may lead to different conclusions about students' knowledge.

Bibliography

Gorsuch, Richard L.
Factor Analysis. W. B. Saunders Co., Philadelphia, PA, 1974.

Guertin, Wilson H. "The Effects of Instructions and Item Order on the Arithmetic Subtest of the Wechsler-Bellevue." Journal of Genetic Psychology, 85:79-83, 1954.

McCormick, Dean R. "The Controversial Development of the Michigan Educational Assessment Program 1969-1977." Doctoral Dissertation, Michigan State University, 1978.

Moore, JoAnne E. "A Comparative Analysis of the Structure of Two Versions of the Grade Ten Michigan Educational Assessment Program Mathematics Test." Doctoral Dissertation, Wayne State University, 1983.